Response of the SNO Detector to High Energy Gamma-Rays

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A two step Monte-Carlo procedure was done in order to quantify the response of the SNO detector to high energy gamma rays produced by (α, γ), $(\alpha, n\gamma)$ and $(\alpha, p\gamma)$ reactions induced by natural radioactivity in the rock and coating of the SNO cavity. In a first step, we used GEANT 3.21 [1] to model the SNO cavity and to track gamma rays and the subsequent electromagnetic radiation from the surface of the cavity up to a spherical surface of 18 m of diameter. The particle type, position and momentum are then recorded and used as input for SNOMAN [2], the dedicated SNO Monte-Carlo code.

The GEANT 3.21 simulation generates gamma-rays uniformly in the cavity walls in all directions in 1 MeV bins from 3 to 12 MeV. Two models were studied: cavity filled with water and cavity empty (air).

As a visual aid, figure 1 shows the projection in the ZX plane of events generated in the cavity walls superimposed with the projection of the events which survive the water shield, i.e., penetrate the region of the photomultiplier support structure.

For the purpose of this study we set standard conditions to the event trigger and data filter, requiring that at least 10 photomultipliers fire and that the events pass the standard SNO event reconstruction program, the FTT fitter.

The results are exemplified in figure 2 where we plot the response of the SNO detector, when filled with water, to gamma-rays originated in the cavity walls with energy between 7 and 8 MeV. This response considers the events which were reconstructed inside the heavy water volume only.

The results of this study are combined with the experimental values obtained from the measurement of the high energy gamma-ray flux in the SNO cavity in order to evaluate the contribution of this background to the experiment.

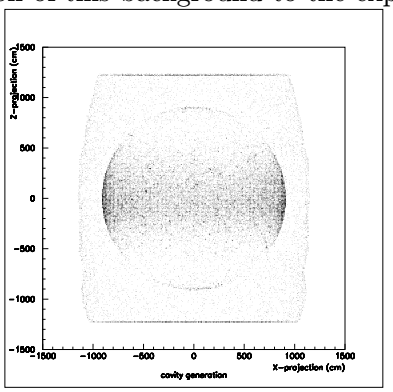

Figure 1: Projection of the GEANT generation in a water filled geometry. In this plot are represented the ZX projection of the position at which events are generated in the cavity walls superimposed to the position where particles intercept a 9 meter sphere. From this sphere on particles are tracked by SNOMAN.

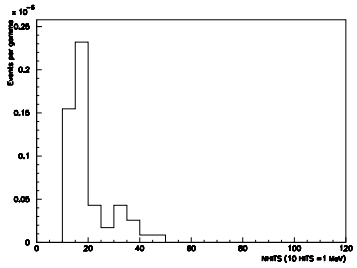

Figure 2: Example of the response of the SNO detector, as a function of the event energy, to gamma-rays of energies between 7 and 8 MeV originated in the cavity walls.

Footnotes and References

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[1] GEANT, CERN Program Library, Long Writeup W5013

[2] SNOMAN, SNO dedicate Monte Carlo code